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Diet of cormorants, mergansers, and kingfishers in northeastern North America

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August 1998

Canadian Technical Report of
Fisheries and Aquatic Sciences No. 2225



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Canadian Technical Report of Fisheries and Aquatic Sciences

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Cat. No. Fs 97-6/2225E ISSN 0706-6457

Correct citation for this publication is:

Cairns, D.K. 1998. Diet of cormorants, mergansers, and kingfishers in northeastern North America. Can. Tech. Rep. Fish. Aquat. Sci. No. 2225: 32 pp.

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Abstract

Cormorant, merganser, and kingfisher diets in northeastern North America are reviewed. Double-crested cormorants (*Phalacrocorax auritus*) breed and forage primarily along the coast, but may invade fresh water during spring runs of anadromous fish. Diets include a substantial fraction of Atlantic salmon (*Salmo salar*) during smolt exodus in rivers whose runs are supplemented by stocking. At other times birds feed on a variety of marine and estuarine species. Great cormorants (*P. carbo*) occupy marine habitats, and chiefly eat marine bottom fish. Common mergansers (*Mergus merganser*) eat juvenile salmon and other freshwater fish during spring and summer, but tend to move toward river mouths and estuaries in late summer. Red-breasted mergansers (*M. serrator*) have a largely coastal distribution, where they feed on estuarine, diadromous, and some salmonid species. Hooded merganser (*Lophodytes cucullatus*) diet in the region is poorly known, but probably includes a variety of fish and invertebrates. Belted kingfishers (*Ceryle alcyon*) live mostly along rivers, where they eat salmonids and other freshwater and diadromous fishes. Mean representation of commercial and recreational prey species is 44% for double-crested cormorants (outside the Atlantic salmon smolt run), 31% for great cormorants, 43% for common mergansers, 3% for red-breasted mergansers,

and 34% for belted kingfishers. Despite large sample sizes (total N > 6,982), reported diets only approximately reflect actual food ingested. Major sources of bias include differential digestion rates, erroneous inclusion of prey from prey stomachs, incomplete spatial and temporal coverage, and over-representation of samples from salmon rivers.

Résumé

Les régimes alimentaires des cormorans, des bec-scies, et des martin-pêcheurs du nord-est de l'Amérique du nord sont passés en revue. Les cormorans à aigrettes (*Phalacrocorax auritus*) se reproduisent et s'alimentent surtout le long des côtes, mais ils peuvent visiter l'eau douce durant les migrations printanières des poissons anadromes. Le régime alimentaire inclut une fraction importante du saumon de l'Atlantique (*Salmo salar*) durant l'exode des sammoneau des rivières dont les populations sont supplémentées par le stockage. Ailleurs, ils mangent une variété de proies marines et estuariennes. Les grands cormorans (*P. carbo*) occupent les habitats marins, et mangent surtout les poissons marins benthiques. Les grands bec-scies (*Mergus merganser*) mangent des saumons juvéniles et d'autres poissons de l'eau douce durant le printemps et l'été, mais ils tendent à se déplacer vers les embouchures et les estuaires des rivières tard en été. Les bec-scies à poitrine rousse (*M. serrator*) ont une distribution principalement cotière; et ils se nourrissent des espèces estuariennes et diadromes parfois incluant les salmonidés. Le régime alimentaire des bec-scies couronnés (*Lophodytes cucullatus*) est peu connu, mais il inclut probablement une variété de poissons et d'invertébrés. Le martin-pêcheur d'Amérique (*Ceryle alcyon*) vit surtout le long des rivières, où ils mangent des salmonidés et d'autres poissons diadromes et de l'eau douce. La représentation des espèces commerciales et sportives est 44% pour le cormoran à aigrettes (à l'extérieur de la période d'exode des sammoneaux), 31% pour le grand cormoran, 43% pour le grand bec-scie, 3% pour le bec-scie à poitrine rousse, et 34% pour le martin-pêcheur d'Amérique. Malgré les échantillons nombreux (N total > 6,982), les régimes alimentaires rapportés reflètent la nourriture ingérée seulement de façon approximative. Les biais principaux incluent les taux de digestion variés, l'inclusion erronée des proies provenant des estomacs des proies, l'échantillonage incomplet en temps et en espace, et la sur-représentation des échantillons des rivières aux saumons.

Introduction

Many species harvested by commercial and recreational fishermen are also taken by bird, mammal, and fish predators. This often leads to accusations that animal piscivores are depleting stocks and reducing human fishing opportunities (Taverner 1915, Elson 1962, Anderson 1985, Draulans 1988, Holt 1989, Neuman et al. 1997). Perceived conflicts between animal and human fisheries are greatest when the resource is highly prized, as is the case with salmon, and the predators are highly visible, as is the case with birds.

This document reviews literature on cormorant, merganser, and kingfisher diets in the Atlantic Provinces, eastern Quebec, and the Atlantic New England states. These birds are conspicuous members of riparian and estuarine ecosystems in northeastern North America, and are often at the centre of controversies regarding impact of predators on fish stocks (Anthony 1994, Krohn et al. 1995, Milton et al. 1995).

Methods

This review is based on published and unpublished dietary investigations on double-crested (*Phalacrocorax auritus*) and great (*P. carbo*) cormorants, common (*Mergus merganser*), red-breasted (*M. serrator*), and hooded (*Lophodytes cucullatus*) mergansers, and belted kingfishers (*Ceryle alcyon*). These species are widely distributed in much of northeastern North America (Table 1), but diet data are lacking for Newfoundland and Labrador, and are available for mergansers only in the Maritime Provinces. Most studies were sponsored by federal, provincial or state agencies, and were prompted by public, and sometimes scientific, concerns regarding avian predation of fish, particularly the Atlantic salmon (see Table 2 for scientific names of fish).

Diet examination was based on stomach contents, vomits, and pellets. Most stomach contents were obtained by shooting. Both adult and nestling cormorants readily vomit when disturbed, which provides an additional source of samples. Investigators also deduced diet from pellets. Cormorants and kingfishers regurgitate pellets consisting mostly of bones and otoliths, which can be easily found in colonies and at roosting places.

Most authors reported their data as percent mass, percent number, or frequency of occurrence. Percent mass is the mass of the taxon of interest as a percent of total sample mass. Percent number is the number of specimens of the taxon of interest as a percent of all specimens in the sample. Percent occurrence is the percent of stomachs, vomits, or pellets which contain at least one specimen of the taxon of interest. Percent volume is equivalent to percent mass, except that quantities are measured volumetrically. Percent mass and percent number sum to 100; frequency of occurrence does not necessarily sum to 100.

Diet compositions are presented as reported in the original papers, or as arithmetic means across geographical regions and across time. Where necessary,

mass, volume, and number values were adjusted to sum to 100 prior to calculation of means.

Because of the interest in avian predation on Atlantic salmon, studies of double-crested cormorant diet during the spring run of salmon smolts have concentrated on areas close to salmon rivers. This bias was corrected by first assuming that birds with access to salmon have a similar dietary breakdown of non-salmon prey as birds without access to salmon. A representative diet for the Maritimes was calculated by weighting diets of birds with and without access to salmon by numbers of birds breeding in colonies whose foraging range includes salmon rivers, as a proportion of total population. Foraging range is taken as 20 km (Hobson et al. 1985, King et al. 1995). The Maritime population breeding within this distance of Atlantic salmon rivers indicated by ASA (1980) was 22,449 pairs, or 69.6% of the regional total (Lock et al. 1994).

Similarly, common merganser and kingfisher diet studies focused on areas where salmon are found. A representative diet for Maritime populations of these species was calculated by weighting diets of birds with and without access to salmon by the area of the Maritimes drained by salmon rivers, or portions of rivers used by salmon, as a proportion of total Maritimes land area. Area drained by salmon habitat, as measured by planimeter from ASA's (1980) map, was 97,058 km², or 74% of total land area.

Red-breasted mergansers are largely coastal nesters in the Maritime provinces, and both red-breasted and common mergansers occupy this habitat in fall and winter (Erskine 1992). However, dietary studies are restricted to river and pond habitats. Diets in coastal habitats were estimated for these species by scaling up estuarine and marine prey in measured diets to 100% of diet. For red-breasted mergansers, a mean diet was calculated for the nesting season by weighting raw and coastal diets by numbers of birds occupying fresh and coastal habitats at this time. Pairs of red-breasted mergansers nesting in fresh water habitats were estimated by applying the exploitation ratio of common mergansers in White's (1957) merganser sampling program (696 birds sampled: Maritime population of 1200 breeding pairs) to the number of sampled red-breasted mergansers (23) (Tables 1, 4 and 5). This yields an estimate of 40 pairs of red-breasted mergansers breeding in fresh water.

Diets

Diet compositions from individual studies are reported to the lowest taxonomic unit in Tables 2-6, which also present mean compositions. Table 7 summarizes diet composition by region and prey group.

Double-crested cormorant

Double-crested cormorants breed colonially along coasts and estuaries in the Atlantic New England states, the Maritime Provinces, and eastern Quebec. A few inland colonies are also found within this region. A small

number of birds breeds in Newfoundland, and none in Labrador (Table 1). This species feeds primarily in salt and brackish water, but may also visit freshwater ponds and rivers, particularly during spring runs of anadromous fish. Double-crested cormorants leave the region in the fall to winter in the southeastern United States (Dolbeer 1991).

Diet composition was estimated from more than 4,352 stomach, vomit, and pellet samples (Table 2). Salmon was a substantial fraction of samples during smolt runs in the Penobscot and Machias Rivers in Maine, the Dunk River on PEI, and the St. Marys River in Nova Scotia in 1986-1987. All of these rivers are stocked with hatchery-reared fish, but may also contain substantial natural runs. Salmon was negligible in Passamaquoddy Bay stomachs sampled in the days following smolt release (Kehoe 1987). Smolts were rare in stomachs collected during smolt runs in the St. Marys area in 1980-1981, when local rivers were not stocked (Milton et al. 1995). No data on cormorant diet are available from other rivers where runs are exclusively wild. In the Maritimes during the smolt run, the proportion of diet composed of salmon, weighted for areas where cormorants have no access to salmon, was 3.3%.

The recovery of Carlin tags at double-crested cormorant colonies near the mouths of rivers which receive stocked salmon also demonstrates double-crested cormorant predation on smolts (Penobscot River, Dube and Godin 1987; Machias River, Meister and Gramlich 1967, Krohn et al. 1995; St Marys River, Farmer et al. ms., Milton et al. 1995). However, the conversion of tag recovery data into estimates of diet composition is problematic because tag recovery rates are difficult to measure and because capture of tagged fish may not be representative of capture of untagged fish of the same species (Reitan et al. 1987, Feltham and MacLean 1996).

During smolt runs, non-salmonid freshwater and estuarine/diadromous prey averaged 62% of sample composition, although this figure may be upwardly biased by preferential sampling in salmon habitat during this period (Table 7). Yellow perch, white sucker, gaspereau (alewife and blueback herring), rainbow smelt, and American eel were the principal prey species. Samples collected during smolt runs also contained a mean of 16% marine prey, reflecting, in some cases, the collection location at river mouths, and, in others, the movement of birds from the sea into the freshwater zone. Overall, commercial and recreational species averaged 73% of reported prey composition during the smolt run.

Double-crested cormorant diet samples collected at times and places other than smolt runs contained negligible Atlantic salmon (0.1%, Table 7). The main salmonid in cormorant diet outside the smolt run was brook trout, which averaged 1.9% of sampled diet. Brook trout were absent from most samples, and the 1.9% figure chiefly reflects the species' 49% representation in samples from freshwater ponds in Prince Edward Island (Table 2).

Outside the smolt run, cormorant diet contained few non-salmonid freshwater fish (mean 2.9% of diet, Table 7). Diet contained a mean of 23% of estuarine/diadromous fish, particularly gaspereau, smelt, eels, and sticklebacks. Atlantic herring, capelin, sand lance, and other pelagic fishes averaged 14% of diet. The largest dietary component was marine bottom fish, which averaged 55% of reported diets. The chief prey were cunners, sculpins, cod, pollock, winter flounder and other flatfish, and rock gunnels and other blenny-like fishes. Overall, commercial and recreational species comprised 44% of reported double-crested cormorant diet outside smolt runs.

Great cormorant

Most great cormorants in North America breed in Nova Scotia, with smaller numbers in Quebec and Prince Edward Island, and a few in insular Newfoundland and Maine (Table 1). In contrast to the double-crested cormorant, great cormorants have an entirely marine breeding distribution in North America, and forage nearly exclusively in salt water. Great cormorants tend to move south in fall, but some apparently overwinter in the region (Chapdelaine 1977, Hogan 1979).

Dietary information for great cormorants is available only from the Atlantic coast of Nova Scotia and from the Magdalen Islands (Table 3). In keeping with their marine habits, great cormorant prey samples contained no salmonids and freshwater fish, and estuarine/diadromous species were only a small component of total diet (mean 4.7%, Table 7). Pelagic fish, particularly sand lance and herring, formed a mean of 15% of diet. The major dietary component (79%) was marine bottom fish. Cunner was important (>25%) at all study sites, and comprised a mean of 37.5% of total diet. Other significant marine bottom fishes were pollock, sculpins, winter flounder and other flatfish, and rock gunnel and other blenny-like fishes. Overall, 31% of reported diet consisted of commercial and recreational species.

Common merganser

Common mergansers are piscivorous ducks which breed throughout most of the forested zone of northeastern North America (Bellrose 1976, Table 1). They commonly inhabit rivers during the breeding season, but tend to move toward river mouths and estuaries in late summer. The species is present in the region year-round, usually wintering in coastal areas and estuaries, but sometimes in fresh water where ice conditions permit.

Common merganser diet is known from 960 stomachs collected in New Brunswick, Nova Scotia, and the Bay of Chaleur area of Quebec (Table 4). Collections were made during merganser predation studies by the Atlantic Salmon Federation (Restigouche River) and by the Fisheries Research Board of Canada (other sites).

Salmon was 37% of diet samples in the Maritime Provinces, but overall salmon contribution, adjusted for areas where salmon are absent, was 27% (Table 7; other

means quoted below are also adjusted). Salmon catch was broken down by age in Restigouche investigations, which showed the leading age class to be 2+, followed by 0+ and 1+ (Table 4). Brook trout and unidentified salmonids contributed an additional 3.7% of diet.

Freshwater fish other than salmonids were 44% of mean diets. White suckers, common shiners, and blacknose dace were the principal species. A mean of 25% of diets were estuarine/diadromous fish, mostly gaspereau, eel, sticklebacks, and killifish. Pelagic and marine bottom fish were negligible in diets. Commercial and recreational species comprised a mean of 43% of diets.

Fall/winter diets, calculated by scaling up the estuarine and marine component of spring/summer diets, were dominated by estuarine and diadromous fish, principally gaspereau, eels, sticklebacks, and killifish.

Red-breasted merganser

The red-breasted merganser breeds throughout northeastern North America, but in the Maritimes its distribution is much more coastal than that of the common merganser. A few red-breasted mergansers nest along rivers, but these birds generally take their broods to the estuary upon hatching. Red-breasted mergansers are present in the region year-round.

Thirty-seven red-breasted merganser stomachs were taken in rivers and ponds in New Brunswick and Nova Scotia (Table 5). Atlantic salmon comprised a mean of 11.7% of diet, and brook and rainbow trout an additional 4.5%. Freshwater fish and estuarine/diadromous fish each contributed 40% of reported diet. The main prey were minnows, white sucker, sticklebacks, and killifish.

Coastal diets, calculated in the same manner as those of common mergansers, consisted principally of sticklebacks and killifish. Overall diet calculated for the nesting season was very similar to calculated coastal diet due to predominance of coastal habitat use.

Hooded merganser

Hooded mergansers breed in New England, southern Quebec, and the Maritime Provinces (Dugger et al. 1994). The species favours forested areas with marshes, small ponds, and streams during both breeding and wintering, but it also makes use of estuaries and coastal areas during winter.

Because hooded mergansers are not widely considered as a threat to sport fishes, their diets have received less attention than those of other mergansers. In a collection of 17 stomachs from Crecy Lake in southwestern New Brunswick, 5.9% of stomachs contained brook or rainbow trout and 23.5 % of stomachs contained banded killifish (Table 5). Hooded mergansers have been reported to eat dragonflies (Odonata) and caddisflies (Trichoptera) in Massachusetts, and predatory diving beetles (Dytiscidae) in Maine (Dugger et al. 1994).

Laboratory studies indicate that hooded mergansers readily take brook trout (Donnelly and Whoriskey 1991).

Diet percent by number of 138 birds, sampled from November to March at various US locations, was 44% fish, 22% crayfish, 10% other crustaceans, 13% aquatic insects, 6% amphibians, and 4% vegetation (Dugger et al. 1994). Percent occurrence in 10 winter samples from Michigan was 50% fish, 50% crayfish, 20% insects, 10% frogs (Salyer and Lagler 1940).

Belted kingfisher

Belted kingfishers breed throughout northeastern North America, except for northern regions above the treeline (Hamas 1994). Their typical habitat is rivers, ponds, and lakes, but they also occur along sheltered salt or brackish shorelines. Migratory behaviour is influenced by ice cover, which prevents access to aquatic prey. Wintering grounds may include southern Nova Scotia and New England, depending on ice conditions (Hamas 1994).

Kingfisher diet is known from 1,389 pellet and stomach samples from the three Maritime Provinces (Table 6). Atlantic salmon comprised a mean of 20% of samples, but only 15% of the total adjusted for non-salmon areas (Table 7; other figures given below are also adjusted). In the Margaree River, where salmon prey were tallied by age, the commonest parr age in samples was 1+, followed by 0+ and 2+ (Table 6). Kingfisher diet also included a mean of 10.2% brook and other trout, for a total salmonid component of 25%.

Other freshwater fish comprised a mean of 31% of diet (Tables 6 and 7). Major species were white sucker, blacknose dace, lake chub, common shiner, and slimy sculpin. Estuarine and diadromous species were 35% of diet. This component was dominated by sticklebacks, particularly the three-spined stickleback, mummichogs, killifish, smelt, and gaspereau. Kingfishers also took crayfish (7.6% of diet), and small quantities of marine fish, amphibians, insects, and mammals. Collectively, commercial and recreational species were a mean of 34% of diet (Table 7).

Discussion

Biases due to methods

None of the standard methods of diet analysis, including percent mass, percent number, and frequency of occurrence, gives an unbiased indication of the proportion of food types ingested by a predator (Duffy and Jackson 1986, Johnstone et al. 1990, Harris and Wanless 1993). In percent mass and percent volume, error can be introduced by differential prey digestibility, with more durable prey being over-represented in reported results. Percent number is biased if prey types vary in size, as large prey are under-reported in results, and small prey are over-reported. Frequency of occurrence depends on the distribution pattern of the prey and on predator behaviour. For example, a prey that occurs in low densities but is widely distributed may have a high frequency of occurrence, even though it is a small component of ingested prey.

In general, the more similar prey types are, the lower the risk of bias. Fish dominate the diet of the predators discussed in this paper (except the hooded merganser), but most also take some invertebrate prey. The greatest bias in dietary results is likely in the estimation of invertebrates as a percent of total diet. Because crustaceans and molluscs have durable exoskeletons, they tend to persist longer in predator stomachs and therefore will be over-reported in studies based on mass, number, and occurrence. Invertebrates may also be over-reported in percent number calculations, because crustaceans, molluscs, and insects taken by piscivorous birds are typically smaller than fish prey.

Sculpins, and to a lesser extent sticklebacks, have hard parts which may lead to greater persistence in predator stomachs. This feature may lead to over-estimation of these species' dietary contribution in comparison with fish which lack heavy armor or spines.

Not all material in predator stomachs has been directly ingested by the predator. Blackwell and Sinclair (1995) reported evidence that a substantial fraction of otoliths in cormorant stomachs were from stomachs of fish that the birds had swallowed. Errors arising from undetected secondary consumption would be particularly likely in analysis of regurgitated pellets, where much of the material is otoliths and other hard parts.

In sum, the dietary information compiled in this review is at best only an approximation of actual food ingested. Bias risk is greatest in estimation of invertebrate contributions, and is relatively less among soft-bodied fishes which lack external hard parts.

Spatial and temporal coverage

Predator diets can vary both seasonally and across geographic areas (Neuman et al. 1997). Despite a large overall sample size (>6,982), sampling coverage is incomplete for some species, areas, and times of the year. Dietary data for double-crested cormorants have the best geographic coverage of the species considered, with extensive sampling in Maine, Nova Scotia, Prince Edward Island and Quebec. Data are absent from Newfoundland, but few cormorants breed there. Surprisingly, no data are available for region's largest wild-run salmon rivers. Double-crested cormorants breed near the mouths of the Saint John, Miramichi, and Restigouche Rivers, but cormorant diets have not been investigated in these areas.

Milton et al. (1988), Blackwell and Krohn (1997) and Hill et al. 1997 reported influxes of double-crested cormorants into rivers during spring runs of anadromous fish. However, not all cormorants participate in these movements, as birds continue to be observed in traditional marine or brackish habitats in spring (Hill et al. 1997, pers. obs.). This report seeks to correct biases due to preferential sampling in areas where smolts are running to sea by weighting means by proportions of birds with access to salmon. However, this correction cannot be considered complete because sampling efforts during

the smolt run have concentrated on rivers and estuaries where salmon are running, leaving other habitat unsampled or undersampled.

Great cormorant diet data are available only from the Atlantic coast of Nova Scotia and from the Magdalen Islands. No information has been collected from Prince Edward Island and the north shore of the Gulf of St. Lawrence, which have significant breeding populations.

Common merganser diets have been thoroughly sampled across New Brunswick and Nova Scotia, but data are unavailable from other areas (except one river in the Bay of Chaleur area, Quebec). The merganser research program which obtained most of the New Brunswick and Nova Scotia samples was explicitly oriented towards salmon depredation (White 1957), leading to the need to weight means by the proportion of non-salmon habitat.

Data on red-breasted merganser diet are available only for New Brunswick and Nova Scotia. Given the small data set (37 stomachs), means are subject to substantial sampling error. Samples are from a mix of salmon and non-salmon habitat, so salmon composition in diet is not subject to systematic bias in favour of salmon habitat.

Diet of hooded mergansers in northeastern North America is known from one collection from southwestern New Brunswick, and from non-quantitative reports from New England. This data set is inadequate to characterize hooded merganser diet in the region, especially since the New Brunswick report includes only fish prey, and the New England sources mention only insects.

Kingfisher diet is known from 1,389 samples from all three Maritime Provinces. This large collection reflects widely distributed geographic coverage, but collection efforts were largely directed at salmon streams (White 1953), leading to upward biases in salmon composition of raw means.

In addition to the gaps in spatial coverage noted above, dietary data for the species considered in this review have major temporal gaps. Most studies were conducted in spring and summer, a handful were conducted in fall, and none was conducted in winter. Temporal data gaps cause the greatest problem for common and red-breasted mergansers because these birds typically occupy estuarine and marine environments in fall and winter. Diet in this habitat is estimated by scaling up the estuarine and marine component of spring and summer samples, but this does not fully correct for bias because birds in spring and summer may not have access to fully marine prey. Calculated estuarine/marine diets are dominated by estuarine species and contain very few marine prey. It is likely that the method used over-estimates estuarine prey and under-estimates marine prey.

Fall and winter data are lacking for cormorants and kingfishers but this gap is less serious because these birds do not exhibit major seasonal habitat shifts.

Yet another source of bias is long-term changes in fish populations which may alter prey available to birds (e.g. Blackwell et al. 1995). Many of the studies summarized herein were conducted several decades ago, and food availability, and therefore diet, may have shifted substantially in the intervening period.

Prey selectivity

Cormorants are frequently called opportunistic foragers that feed on whatever prey is locally abundant (e.g. Kirby et al. 1996, Milton et al. 1995). Mouth size imposes an upper limit to the size of prey that can be ingested (Swennen and Duiven 1991). However, cormorants have large gapes and can take fish up to one half their body weight (Dieperink 1995), so size constraints are unlikely to limit predation on most fish cormorants encounter.

In contrast to this view of cormorants as non-selective feeders, Lewis (1929) reported that captive nestling double-crested cormorants would accept any white-fleshed fish, but favoured sculpins. Birds were reluctant to eat trout, which they took only in small quantities even when deprived of other food. A toad was eagerly taken, but molluscs and a rock crab were actively rejected. Lewis (1929) assigned this distaste for trout to the fish's oily flesh (although brook trout energy density is typical of other fish, indicating normal lipid concentrations; Table 2). Nestling cormorants have no control over fish delivered to them by their parents, and there is no information on whether this reported dislike of trout continues after they reach independence.

Working in the Pollett River, southeast New Brunswick, Elson (1962) compared percent number of fish species in common merganser diet to percent number of fish in habitat exploited by these species. He then calculated 'forage ratios' as the quotient of proportion of the prey species in the diet and proportion of the prey species in the habitat. For the Atlantic salmon, the forage ratio was 4.1, indicating that salmon were taken in proportionately greater numbers than their density would warrant. Forage ratios for other species were 2.4 for suckers, 0.4 for chub, 0.4 for dace, 0.1 for eels, and 24.2 for other fish.

The high forage ratio for Atlantic salmon does not necessarily prove that mergansers actively select salmon while feeding, as selection may be on the basis of size or ease of capture which may vary among species. It must also be noted that the highest forage ratios were those for 'other' fish, which included killifish, sculpins, and sticklebacks. Since density information is not presented for these fish, it is not possible to calculate their species-specific forage ratios.

Salyer and Lagler (1940) found that common mergansers wintering in Michigan fed on trout in a greater proportion than was present in the habitat. These authors believed that the higher trout numbers were due to their larger size in relation to the small fishes which were their alternative prey.

Sjoberg (1988) conducted a series of experiments to elucidate prey preferences in common and red-breasted mergansers. He found that hungry birds showed no species preference when prey was readily available, but that satiated birds took brown trout and salmon in preference to minnows, sculpins, and other fish. Experiments in a stream tank with a simulated natural bottom showed that hungry birds selected larger fish regardless of species, but that satiated birds preferred small fish regardless of species.

Elson (1962) reported that belted kingfishers preyed disproportionately on salmon in the Pollett River (forage ratio 3.1). Other forage ratios reported by Elson (1962) were 1.6 for suckers, 0.7 for chub, 0.9 for dace, 0.1 for eels, and 42.8 for other fish. However, the same caveats apply to these results as those noted above for Elson's (1962) common merganser data. Eipper (1956) reported that trout removals by kingfishers relative to the number of trout in the stream were higher than for some other fish species. Experiments have shown that kingfisher diet is not a simple function of prey preference, but strongly depends on the interplay between prey behaviour and habitat structure (Hockett 1994, Kelly 1996).

Pelagic seabirds often encounter prey with widely varying energy densities (e.g. 4.2 to 10.3 kJ/g, Monteverecchi et al. 1984), which may lead predators to select prey on the basis of energy value. Prey commonly available to cormorants, mergansers, and kingfishers tends to vary less in energy content (Table 2), so energy densities are probably not a major factor in prey choice by these species.

Conclusions

This review has shown that cormorants, mergansers, and kingfishers in northeastern North America have diverse diets that reflect a broad range of species found in their habitats. Prey selection is undoubtedly influenced by size and ease of capture, but diet may also be affected by capture vulnerability of prey which can be altered by previous experience (Hockett 1994), and by human influences such as dams which concentrate fish (Blackwell and Krohn 1997). Prey choice by wild piscivores is difficult to study, and it is not clear whether free-ranging birds select for or against any fish species on the basis of species alone.

Cormorants, mergansers and kingfishers consume juvenile Atlantic salmon when the predators and prey are in the same area at the same time. Belted kingfishers and common mergansers have the highest spatial/temporal overlap with salmon and have the highest proportion of salmon in their diet. Double-crested cormorants and red-breasted mergansers are largely coastal, but may consume salmon in rivers and river mouths. Hooded mergansers probably eat few salmon because most occupy slow-moving water bodies not favored by salmon. Great cormorants rarely enter fresh water and are not known to consume salmon.

Cormorant, merganser, and kingfisher diets include a substantial fraction of commercial and recreational fishes in addition to Atlantic salmon. Predation mortality may be additive, meaning that total mortality increases, or it may be compensatory, meaning that the prey would have died from other causes if the predation had not occurred. Since it is not clear whether predation by cormorants, mergansers, and kingfishers is additive or compensatory, controversies over the role of these predators in aquatic systems are likely to continue (Anthony 1994, Duffy and Schneider 1994, Milton et al. 1995).

Acknowledgments

I thank R.B. Allen, B.F. Blackwell, K. Davidson, G.J. Farmer, W.B. Krohn, G.R. Milton, R. Pickard and J.-F. Rail, for comments, advice, and unpublished information.

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Table 1
Estimated populations (breeding pairs) of cormorants, mergansers, and kingfishers in the coastal New England states, the Atlantic Provinces, and Quebec.

	New England		New Brunswick		Prince Edward Island		Nova Scotia		Quebec		Newfoundland (island)		Labrador	
	Pairs	Source ^a	Pairs	Source	Pairs	Source	Pairs	Source	Pairs	Source	Pairs	Source	Pairs	Source
Double-crested cormorant	37,648	K95	9,257	L94	9,769	F	12,000	M95	27,300	CB95	172	L94	0	L94
Great cormorant	>84	DH85	0	L94	507	F	3,700	M95	1,101	L94	131	L94	0	L94
Common merganser	p ^b		700	E92	0	E92	500	E92	81,500 ^c	A95	1,700	G87	17,980 ^d	GW87
Red-breasted merganser	p		500	E92	150	E92	300	E92	p		2,400	G87	p	
Hooded merganser	p		300	E92	60	E92	5	E92	p		0	E87	0	E87
Belted Kingfisher	p		1,700	E92	1,000	E92	4,100	E92	p		p	p	p	p

*Sources: A95, Alvo 1995; CB95, Chappelaine and Bédard 1995; DH85, Drury and Hatch 1985; E87, Erskine 1987; E92, Erskine 1992; F, PEI Fish and Wildlife Division unpublished; G87, Goudie 1987; GW87, Goudie and Whitman 1987; K95, Krohn et al. 1995; L94, Lock et al. 1994; M95, Milton et al. 1995

^bPresent

^cData for all mergansers

^dData for common and red-breasted mergansers

Table 2

Percent diet composition of double-crested cormorants in north-eastern North America, and energy density of their prey.

Prey	Exploit- ation status*		Energy density ^b kJ/g		Penobscot Bay		Southwestern Penobscot Bay		Penobscot River, below head of tide		Penobscot River, below head of tide		
	wet mass	Source	Shoals, New Hampshire	Boothbay Harbor, Maine	Off Boothbay Harbor, Maine	White Is., near Boothbay Harbour, Maine	Southwestern Penobscot Bay	Penobscot Bay	Penobscot River, below head of tide	Penobscot River, below head of tide	Penobscot River, below head of tide	Penobscot River, below head of tide	
Sampling dates													
Sample type ^c													
Diet analysis type ^d													
N													
Source													
Salmonids													
All - salmon smolt, <i>Salmo salar</i> , exclusively wild	R	4.38 G. Farmer unpubl.											
Adult salmon smolt in stocked rivers	R	5.44 Farmer et al. 1979											
Brook trout, <i>Salvelinus fontinalis</i>	R	5.61 Cunjak 1988											
Rainbow trout, <i>Oncorhynchus mykiss</i>	R	7.37 Bennet et al. 1985											
Whitefish, <i>Careproctus</i> sp.	R	6.15 Sidwell 1981											
Unidentified salmonids, Salmonidae	R												
Freshwater fish													
Yellow perch, <i>Perca flavescens</i>	CR	4.48 Sidwell 1981											
Brown bullhead, <i>Ictalurus nebulosus</i>	CR												
Smallmouth bass, <i>Micropterus dolomieu</i>	R												
Pumpkinseed, <i>Lepomis gibbosus</i>	R												
Sunfish, <i>Lepomis</i> sp.	R	3.27 Sidwell 1981											
Unidentified centrarchid	R												
Chain pickerel, <i>Esox niger</i>	R												
Golden shiner, <i>Notemigonus crysoleucas</i>	R												
Common shiner, <i>Notropis cornutus</i>	R												
Shiner, <i>Notemigonus</i> or <i>Notropis</i>	R												
Unidentified Cyprinidae													
White sucker, <i>Catostomus commersoni</i>		4.14 Sidwell 1981											
Unidentified sucker, <i>Catostomus</i> sp.													
Estuarine/diadromous fish													
Alewife, <i>Alosa pseudoharengus</i>	C	6.85 Rotiliere & Tucker 1982											
Blueback herring, <i>Alosa aestivalis</i>	C	7.70 Steimle and Terranova 1985											
Gasperneau, <i>A. pseudoharengus</i> , or <i>A. aestivalis</i>	C												
American shad, <i>Alosa sapidissima</i>	C												
Rainbow smelt, <i>Osmerus mordax</i>	CR	4.90 Steimle and Terranova 1985											
American eel, <i>Anguilla rostrata</i>	CR	6.66 Rotiliere and Tucker 1982											
Atlantic tomcod, <i>Microgadus tomcod</i>	CR	5.91 Dunn 1975											
Atlantic silverside, <i>Menidia menidia</i>	C	4.97 Lambert 1985											
White perch, <i>Morone americana</i>	R												
Northern pectoral, <i>Synodus fuscus</i>		26.88											
Three-spined stickleback, <i>Gasterosteus aculeatus</i>													
Four-spined stickleback, <i>Astyanax quadracanthus</i>													
Ninespine stickleback, <i>Pungitius pungitius</i>													
Unidentified sticklebacks													
Banded killifish, <i>Fundulus diaphanus</i>													
Mummichog, <i>Fundulus heteroclitus</i>													
Unidentified Cyprinodontidae													
Pelagic fish and squid													
Atlantic herring, <i>Clupea harengus</i>	C	7.15 Montevechi and Barrett 1987											
Round herring, <i>Etrumeus teres</i>	C	4.19 Sidwell 1981											
Atlantic menhaden, <i>Brevoortia tyrannus</i>	C	4.23 Sidwell 1981											
Unidentified Clupeidae	C												
Capelin, <i>Mallotus villosus</i>	C	4.20 Montevechi et al. 1984											
Atlantic mackerel, <i>Scomber scombrus</i>	C	10.30 Montevechi et al. 1984											
Sand lance, <i>Ammodytes</i>		6.88 Birthistle and Nettership 1987											
Butterfish, <i>Papilloculiceps longiceps</i>	C	4.69 K. Atney and A.W. Diamond unpubl.											
Squid	C	4.30 Montevechi et al. 1984											

Table 2. Double-crested cormorant diet (continued)

Prey	Exploit-		Energy density ^b		Isles of		White Is.,		Southwestern		Penobscot		Penobscot		Penobscot	
	ation	wet	Source	kJ/g	mass	New	Hampshire	Maine	Boothbay	Penobscot	Bay	Penobscot	Bay	River,	River,	River,
	status*															
Marine bottom fish																
Atlantic cod, <i>Gadus morhua</i>	C	4.09	Birchhead and Nettleship 1987													
Pollack, <i>Pollachius virens</i>	C	4.40	Dunn 1975													
White hake, <i>Urophycis tenuis</i>	C	6.30	Steimle and Terranova 1985													
Silver hake, <i>Merluccius bilinearis</i>	C	4.60	Steimle and Terranova 1985													
Unidentified hake	C	5.68	Sidwell 1981													
Unidentified gadids	C															
Lumpfish, <i>Cyclopterus lumpus</i>	C															
Redfish, <i>Sebastodes marinus</i>	C	3.73	Sidwell 1981													
Winter flounder, <i>Pseudopleuronectes americanus</i>	C	5.28	Dunn 1975													
Yellowtail flounder, <i>Limanda ferruginea</i>	C	4.40	Steimle and Terranova 1985													
Summer flounder, <i>Paralichthys dentatus</i>	C															
American plaice, <i>Hippoglossoides platessoides</i>	C	3.85	Sidwell 1981													
Unidentified flatfish	C	5.24	Dunn 1975													
Cunner, <i>Tautogolabrus adspersus</i>	C															
Sculpins																
Arctic blightfin sculpin, <i>Gymnocephalus tricuspidis</i>																
Grubby, <i>Myoxocephalus aeneus</i>																
Longhorn sculpin, <i>Myoxocephalus octodecemspinosis</i>																
Shortnose sculpin, <i>Myoxocephalus scorpioides</i>																
Sea raven, <i>Hemitripterus americanus</i>																
Mustache sculpin, <i>Triglops murrayi</i>																
Unidentified sculpins																
Blenny-like fishes																
Ocean pout, <i>Macrozoarces americanus</i>																
Unidentified pout, <i>Zaoreidae</i>																
Rock gurnet, <i>Pholis gunnellus</i>																
Banded gurnet, <i>Pholis fasciata</i>																
Gurnard, <i>Pholidapus</i> spp.																
Whynmouth, <i>Cryptacanthodes maculatus</i>																
Snake blenny, <i>Lutjanus kuhni</i> <i>pretaefasciatus</i>																
Radiated shanny, <i>Ulvaria subtilifurca</i>																
Crustaceans																
Lobster, <i>Homarus americanus</i>	C	4.80	Steimle and Terranova 1985													
Other crustaceans		3.77	Tyler 1973													
Molluscs		2.01	Cummins and Wuycheck 1971													
Unidentified prey																
Total commercial and recreational																
*C, commercially fished; R, recreationally fished																

^bSome energy densities are calculated from proximate composition using values supplied by Weatherley and Gill 1983

*Calculated from identified prey only. Percentages are adjusted to sum to 100 prior to calculation of the mean.

*The two samples from the Dusk River in May 1985 were pooled prior to calculation of the mean

*Mean weighted by the percent (69.6%; ASA 1980, Lock et al. 1984) of concomitant populations breeding in colonies within the foraging range (20 km; Hobson et al. 1989, King et al. 1995) of salmon rivers.

Birds from colonies outside this range are assumed to not eat salmon.

'Mean weighted by duration of the smolt run (30 days; Jasnop 1975, Ruggles 1980, Curjak et al. 1983) as a percent of the occupancy period in the Maritime Provinces (1 April - 1 November, 215 days).

*Samples collected during the smolt run

*Sample types were regurgitated pellets (Pellet), regurgitated whole stomach contents (Vomit), and stomach contents of birds which were shot (Stomach).

For a given taxon, diet composition was calculated as percent of total sample mass (% mass), percent of total number of prey items (% number), percent of total volume (% volume), and sum of the percent of each prey species divided by the number of stomachs analysed (relative importance).

*Reported here as means across time (two periods) and place (three areas) of mean % volume of the 10 most important prey taxa found in each area. Other taxa also present are indicated as p
*Percentages may be slightly upwardly biased because the volume of some prey was not measured

Table 2. Double-crested cormorant diet (continued)

Prey	Penobscot River, above head of tide	Penobscot River, above head of tide	Machias River and vicinity, Maine	Machias River and vicinity, Maine	Passe- mentimia County, NS	Salt water, near Lunenburg, Halifax, and Musaboom, Halifax Co., NS	Islands near water, St. Mary's R. & vicinity, NS	Islands, Eastern & Shore rivers, NS	Islands, Eastern & Shore rivers, NS	Eastern Shore rivers, NS
Sampling dates	Apr	May	18 Apr-10	16 May-15	19-31 May	7-20 Jul	30 May-22	12-22 Jul	20 May-24	Apr-Jun
Sample type^a	1986-1988	1982-1983 ^a	May 1987 ^a	Jun 1987	1986 ^a	1956-57	Jul 1971	14 Jun 1957	Jul 1979-80	1980-1981 ^a
Diet analysis type^b	Stomach	Stomach	Stomach	Stomach	Stomach	Stomach	Pellet	Ch. vomit	Stomach	Stomach
N	% occur.	% occur.	% occur.	% occur.	% occur.	% number	% number	% number	% number	% number
Source	15	127	36	20	53	N/A	N/A	21	288	65
Blackwell et al. 1987	Blackwell et al. 1987	Blackwell et al. 1987	Blackwell et al. 1987	Meister & Kehoe 1987	Meister & Gramlich 1987	Ross 1986, 1987	Lewis 1974-76	Lewis 1957	Million et al. 1988	Million et al. 1988
Salmonids										
All. salmon smolt, <i>Salmo salar</i> , exclusively wild									0.60	18.00
All. salmon smolt in stocked rivers									0.30	2.80
Brook trout, <i>Salvelinus fontinalis</i>										
Rainbow trout, <i>Oncorhynchus mykiss</i>										
Whitefish, <i>Coregonus</i> sp.										
Unidentified salmonids, Salmonidae									1.30	5.80
Freshwater fish									4.60	11.20
Yellow perch, <i>Perca flavescens</i>										
Brown bullhead, <i>Ictalurus nebulosus</i>										
Smallmouth bass, <i>Micropterus dolomieu</i>										
Pumpkinseed, <i>Lepomis gibbosus</i>	36.10	8.10	5.75							
Sunfish, <i>Lepomis</i> sp.	19.45	0.47								
Unidentified centrarchid										
Chain pickerel, <i>Esox niger</i>										
Golden shiner, <i>Notemigonus crysoleucas</i>										
Common shiner, <i>Notropis cornutus</i>										
Shiner, <i>Notemigonus</i> or <i>Notropis</i>										
Unidentified Cyprinidae										
White sucker, <i>Catostomus commersoni</i>										
Unidentified sucker, <i>Catostomus</i> sp.	9.76	9.82	15.00	7.55						
	33.30	5.17		15.00						
Estuarine/diadromous fish										
Alewife, <i>Alosa pseudoharengus</i>										
Blueback herring, <i>Alosa aestivalis</i>										
Gaspereau, <i>A. pseudoharengus</i> , or <i>A. aestivalis</i>										
American shad, <i>Alosa sapidissima</i>										
Rainbow smelt, <i>Osmotr mordax</i>										
American eel, <i>Anguilla rostrata</i>										
Atlantic tomcod, <i>Microgadus tomcod</i>										
Atlantic silverside, <i>Harelda menidia</i>										
White perch, <i>Morone americana</i>										
Northern pikefish, <i>Synodus fuscus</i>										
Three-spined stickleback, <i>Gasterosteus aculeatus</i>										
Four-spined stickleback, <i>Astyanax quadracus</i>										
Nin-spined stickleback, <i>Pungitius pungitius</i>										
Unidentified sticklebacks										
Banded killifish, <i>Fundulus diaphanus</i>										
Mummichog, <i>Fundulus heteroclitus</i>										
Unidentified Cyprinodontidae										
Pelagic fish and squid										
Atlantic herring, <i>Clupea harengus</i>										
Round herring, <i>Etrumeus teres</i>										
Atlantic mackerel, <i>Scomber scombrus</i>										
Sand lance, <i>Ammodytes</i>										
Butterfish, <i>Fenestrilus triacanthus</i>										
Squid										

^aAll. salmon smolt, *Salmo salar*, exclusively wild^bAll. salmon smolt in stocked riversBrook trout, *Salvelinus fontinalis*Rainbow trout, *Oncorhynchus mykiss*Whitefish, *Coregonus* sp.

Unidentified salmonids, Salmonidae

Yellow perch, *Perca flavescens*Brown bullhead, *Ictalurus nebulosus*Smallmouth bass, *Micropterus dolomieu*Pumpkinseed, *Lepomis gibbosus*Sunfish, *Lepomis* sp.

Unidentified centrarchid

Chain pickerel, *Esox niger*Golden shiner, *Notemigonus crysoleucas*Common shiner, *Notropis cornutus*Shiner, *Notemigonus* or *Notropis*

Unidentified Cyprinidae

White sucker, *Catostomus commersoni*Unidentified sucker, *Catostomus* sp.Alewife, *Alosa pseudoharengus*Blueback herring, *Alosa aestivalis*Gaspereau, *A. pseudoharengus*, or *A. aestivalis*American shad, *Alosa sapidissima*Rainbow smelt, *Osmotr mordax*American eel, *Anguilla rostrata*Atlantic tomcod, *Microgadus tomcod*Atlantic silverside, *Harelda menidia*White perch, *Morone americana*Northern pikefish, *Synodus fuscus*Three-spined stickleback, *Gasterosteus aculeatus*Four-spined stickleback, *Astyanax quadracus*Nin-spined stickleback, *Pungitius pungitius*

Unidentified sticklebacks

Banded killifish, *Fundulus diaphanus*Mummichog, *Fundulus heteroclitus*

Unidentified Cyprinodontidae

Capelin, *Mallotus villosus*Atlantic mackerel, *Scomber scombrus*Sand lance, *Ammodytes*Butterfish, *Fenestrilus triacanthus*

Unidentified Clupeidae

Capelin, *Mallotus villosus*Atlantic mackerel, *Scomber scombrus*Sand lance, *Ammodytes*Butterfish, *Fenestrilus triacanthus*

Squid

Table 2. Double-crested cormorant diet (continued)

Prey	Penobscot River, above head of tide	Penobscot River, above head of tide	Penobscot River, head of tide	Machias River and vicinity, Maine	Machias River and vicinity, Maine	Machias River and vicinity, Maine	Passamaquoddy Bay, NB	Passamaquoddy Bay, NS	Islands near Lunenburg, Halifax, and Mushaboom, NS	Islands, Eastern Shore rivers, NS	Islands, Eastern Shore rivers, NS	Islands, Eastern Shore rivers, NS	
Marine bottom fish													
Atlantic cod, <i>Gadus morhua</i>									4.00	39.60	2.80		
Pollack, <i>Pollachius virens</i>									30.50	0.70	0.30		
White hake, <i>Urophycis tenuis</i>													
Silver hake, <i>Merluccius bilinearis</i>													
Unidentified hake													
Lumpfish, <i>Cyclopterus lumpus</i>													
Redfish, <i>Sebastodes marinus</i>													
Winter flounder, <i>Pseudopleuronectes americanus</i>													
Yellowtail flounder, <i>Limanda ferruginea</i>													
Summer flounder, <i>Paralichthys dentatus</i>													
American plaice, <i>Hippoglossoides platessoides</i>													
Unidentified flatfish													
Cunner, <i>Tautogaolabrus adspersus</i>													
Scorpions													
Arctic staghorn sculpin, <i>Gymnocanthus tricuspidatus</i>													
Grubby, <i>Myoxocephalus aeneus</i>													
Longhorn sculpin, <i>Myoxocephalus octodecemspinosis</i>													
Shorthorn sculpin, <i>Myoxocephalus scorpioides</i>													
Sea raven, <i>Hemitripterus americanus</i>													
Mustache sculpin, <i>Triglops murrayi</i>													
Unidentified sculpins													
Blenny-like fishes													
Ocean pout, <i>Macrozoarces americanus</i>													
Unidentified pout, <i>Zoarcidae</i>													
Rock gurnet, <i>Pholis gunnellus</i>													
Banded gurnet, <i>Pholis fasciata</i>													
Gurnets, <i>Pholis</i> spp.													
Whymouth, <i>Cryptacanthodes maculatus</i>													
Snake blenny, <i>Lumpenus lumpensiformis</i>													
Radiated shanny, <i>Ulvaria subbifurcata</i>													
Crustaceans													
Lobster, <i>Homarus americanus</i>													
Other crustaceans													
Molluscs													
Unidentified prey													
Total commercial and recreational	55.55	78.83	67.29	50.00	33.96	27.50	15.69	41.10	3.20	55.70	59.50	75.10	

P

Table 2. Double-crested cormorant diet (continued)

Prey	Durrell Point, Malpeque Bay, PEI	Fresh-water ponds, PEI	Barrier-beach ponds, PEI	Estuaries, PEI	Lower Dunk River, PEI	Magdalen Islands, Que.	Gaspé Peninsula, Que.	Peré, Gaspé Peninsula, Que.	Estuary of York River, Gaspé Peninsula, Que.
Sampling dates									
July	20 Jun-21 Aug	May-Oct	May-Oct	8-20 May	2-3 May	4-10 May	16 Jun-16	23 May-26	May-Aug
1985	1985-86	1985-1986	1985	1983 ^a	1985 ^a	1985 ^a	1985 ^a	1978	1978
Vomit		Stomach	Stomach	Stomach	Stomach	Stomach	Stomach	Pal/Vom.	Pal/Vom.
% mass	% mass	% mass	% mass	% mass	% mass	% mass	% mass	% mass	% mass
N	10	108	58	14	21	14	14	512	340
Source	1988	1988	1988	1988	1988	1988	1988	Hill et al. 1997	Pilon et al. 1983
									Lewis 1929
									Taverner 1915
									Taverner 1915
Salmonids									
Atl. salmon smolt, <i>Salmo salar</i> , exclusively wild									
Brown bullhead, <i>Ictalurus nebulosus</i>									
Brook trout, <i>Salvelinus fontinalis</i>									
Rainbow trout, <i>Oncorhynchus mykiss</i>									
Whitefish, <i>Coregonus</i> sp.									
Unidentified salmonids, Salmonidae									
Freshwater fish									
Yellow perch, <i>Perca flavescens</i>									
Smallmouth bass, <i>Micropterus dolomieu</i>									
Pumpkinseed, <i>Lepomis gibbosus</i>									
Sunfish, <i>Lepomis</i> sp.									
Unidentified centrarchid									
Chain pickerel, <i>Esox niger</i>									
Golden shiner, <i>Notemigonus crysoleucas</i>									
Common shiner, <i>Notropis cornutus</i>									
Shiner, <i>Notemigonus</i> or <i>Notropis</i>									
Unidentified Cyprinidae									
White sucker, <i>Catostomus commersoni</i>									
Unidentified sucker, <i>Catostomus</i> sp.									
Estuarine/diadromous fish									
Alewife, <i>Alosa pseudoharengus</i>									
Blueback herring, <i>Alosa aestivalis</i>									
Gasperila, <i>A. pseudoharengus</i> , or <i>A. aestivalis</i>									
American shad, <i>Alosa sapidissima</i>									
Rainbow smelt, <i>Osmotrurus mordax</i>									
American eel, <i>Anguilla rostrata</i>									
Atlantic tomcod, <i>Micropogonias tomcod</i>									
Atlantic silverside, <i>Menidia menidia</i>									
White perch, <i>Morone americana</i>									
Northern pinfish, <i>Syngnathus fuscus</i>									
Three-spined stickleback, <i>Gasterosteus aculeatus</i>									
Four-spined stickleback, <i>Aplochilus quadracus</i>									
Ninespined stickleback, <i>Pungitius pungitius</i>									
Unidentified sticklebacks									
Banded killifish, <i>Fundulus diaphanus</i>									
Mummichog, <i>Fundulus heteroclitus</i>									
Unidentified Cyprinodontidae									
Pelagic fish and squid									
Atlantic herring, <i>Clupea harengus</i>									
Round herring, <i>Etrumeus teres</i>									
Atlantic menhaden, <i>Brevoortia tyrannus</i>									
Capelin, <i>Mallotus villosus</i>									
Atlantic mackerel, <i>Scomber scombrus</i>									
Sand lance, <i>Ammodytes</i>									
Batterfish, <i>Pogonias ciananthus</i>									
Squid									

Table 2. Double-crested cormorant diet (continued)

Prey	Commercial										Recreational										Total commercial + recreational									
	Durrell Point, Eastern PEI	Ram I., Malpeque Bay, PEI	Fresh-water ponds, PEI	Barrier-beach ponds, PEI	Estuaries, PEI	Lower Dunk River, PEI	Lower Dunk River, PEI	Scales*, Magdalen Islands, Què.	Magdalen Islands, Què.	Gaspé Peninsula, Què.	Percé, Gaspé Peninsula, Què.	Estuary of York River, Gaspé Peninsula, Què.																		
Marine bottom fish																														
Atlantic cod, <i>Gadus morhua</i>																					0.40	3.50								
Pollock, <i>Pollachius virens</i>																														
White hake, <i>Urophycis tenuis</i>																					37.10									
Silver hake, <i>Merluccius bilinearis</i>																														
Unidentified hake																														
Unidentified gadids																														
Lumpfish, <i>Cyclopterus lumpus</i>																														
Redfish, <i>Sebastodes marinus</i>																														
Winter flounder, <i>Pseudopleuronectes americanus</i>																														
Yellowtail flounder, <i>Limanda ferruginea</i>																														
Summer flounder, <i>Paralichthys dentatus</i>																														
American plaice, <i>Hippoglossoides platessoides</i>																														
Unidentified flatfish																														
Cunner, <i>Tautogolabrus adspersus</i>																														
Sculpins																														
Arctic stag horn sculpin, <i>Gymnothorax bifurcus</i>																														
Grubby, <i>Myoxocephalus aeneus</i>																														
Longhorn sculpin, <i>Myoxocephalus octodecemspinosis</i>																														
Shortnose sculpin, <i>Myoxocephalus scorpius</i>																														
Sea raven, <i>Hemitripterus americanus</i>																														
Moustache sculpin, <i>Triglops murrayi</i>																														
Unidentified sculpins																														
Bleenny-like fishes																														
Ocean pout, <i>Macrozoarces americanus</i>																														
Unidentified pout, Zoarcidae																														
Rock gunnel, <i>Pholis gunnellus</i>																														
Banded gunnel, <i>Pholis fasciata</i>																														
Gunnels, <i>Pholis</i> spp.																														
Wrymouth, <i>Cryptacanthodes maculatus</i>																														
Snake blenny, <i>Lutjanus lutjanus</i>																														
Radiated shanny, <i>Ulvaria subbifurcata</i>																														
Crustaceans																														
Lobster, <i>Homarus americanus</i>																														
Other crustaceans																														
Molluscs																														
Total commercial and recreational	73.90	30.40	77.90	69.20	48.00	100.00	100.00	89.20	33.10	28.50	63.30	33.33	50.00																	

Table 2. Double-crested cormorant diet (continued)

Table 2. Double-created coromant diet (continued)

Prey	St.	St. Lawrence estuary, Que.	Near St. Mary's Islands, Que., NE	Harrington Harbour, NE	Gulf of Maine		PEI		Maritime		Quebec		All regions								
					Smolt		Non smolt		Non smolt run		Non smolt		Smolt								
					run	smolt	run	smolt	run	smolt	run	smolt	run	smolt							
Marine bottom fish																					
Atlantic cod, <i>Gadus morhua</i>			0.90	0.00	0.04	1.43	10.90	0.00	0.00	0.48	4.84	4.24	0.60	0.48	2.88						
Pollock, <i>Pollachius virens</i>			0.90	0.00	1.11	0.15	7.80	0.00	0.00	0.05	3.47	2.99	0.00	0.05	2.23						
White hake, <i>Urophycis tenuis</i>			0.00	0.00	0.00	0.00	5.30	0.00	0.00	0.05	4.12	3.55	0.00	0.00	1.33						
Silver hake, <i>Merluccius bilinearis</i>			0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.01						
Unidentified hake			0.00	0.00	0.15	0.30	0.00	0.00	0.05	0.05	0.13	0.12	0.00	0.05	0.08						
Unidentified gadids			0.00	0.00	7.26	0.08	0.00	0.00	2.42	2.43	0.03	0.37	0.00	2.42	0.02						
Lumpfish, <i>Cyclopterus lumpus</i>			0.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00						
Redfish, <i>Sebastodes marinus</i>			0.00	1.72	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01						
Winter flounder, <i>Pseudopleuronectes americanus</i>			0.55	4.83	0.35	3.42	0.00	0.00	0.67	0.67	1.52	1.40	0.00	0.30	2.06						
Yellowtail flounder, <i>Limanda ferruginea</i>			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00						
Summer flounder, <i>Paralichthys dentatus</i>			0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01						
American plaice, <i>Hippoglossoides platessoides</i>			0.00	0.00	0.00	0.05	0.00	0.00	0.00	0.00	0.02	0.02	0.00	2.45	0.00						
Unidentified flatfish			13.10	10.30	5.38	0.34	0.76	0.00	0.10	0.00	0.00	0.51	4.74	11.18	0.11						
Cunner, <i>Tautogolabrus adspersus</i>			0.28	17.84	0.00	27.38	0.00	12.04	0.00	0.00	21.54	18.53	4.96	0.09	15.56						
Sculpins			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00						
Arctic stag horn sculpin, <i>Gymnocephalus tricuspidis</i>			0.00	0.22	0.00	0.00	0.00	4.35	0.00	0.00	0.38	2.91	4.72	0.00	0.00						
Grubby, <i>Myoxocephalus thompsoni</i>			7.10	4.95	0.00	3.53	0.00	0.00	7.10	7.12	1.57	2.34	0.48	2.37	2.32						
Longhorn sculpin, <i>Myoxocephalus octodecemspinosus</i>			0.69	3.97	0.82	5.40	0.00	0.00	0.96	0.99	2.40	2.20	0.00	0.50	2.34						
Shortnose sculpin, <i>Myoxocephalus scorpioides</i>			0.00	0.14	0.00	0.03	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.04						
Sea raven, <i>Hemitripterus americanus</i>			32.37	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.04	0.00	1.01						
Moustache sculpin, <i>Triglops murrayi</i>			2.00	1.00	1.58	8.87	0.00	7.53	0.00	0.00	1.46	3.35	3.08	14.81	0.52						
Blenny-like fishes			0.24	0.18	0.00	0.03	0.00	0.00	0.24	0.24	0.01	0.04	0.00	0.08	0.05						
Ocean pout, <i>Macrozoarces americanus</i>			0.07	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.01						
Unidentified poli, Zoarcidae			32.80	4.05	17.09	0.82	0.00	0.40	1.12	1.12	7.91	6.96	4.36	5.55	6.48						
Rock gunnel, <i>Pholis gunnelus</i>			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00						
Banded gunnel, <i>Pholis fasciata</i>			13.10	4.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.65	0.00	0.66						
Gurnard, <i>Pholis</i> spp.			0.00	1.48	0.00	6.63	0.00	0.00	0.00	0.00	2.94	2.53	0.00	0.00	2.02						
Whymouth, <i>Cryptacanthodes maculatus</i>			0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01						
Snake blenny, <i>Lumpenus lumpeniformis</i>			0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01						
Radiated shanny, <i>Uvula subhifurcata</i>			Crustaceans																		
Lobster, <i>Homarus americanus</i>			0.30	0.20	0.33	10.92	10.71	0.00	0.98	0.27	1.05	1.06	0.65	0.70	0.34						
Other crustaceans						1.03	1.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.07						
Molluscs			19.50	7.90	Total commercial and recreational	63.30	46.00	19.24	62.56	38.81	72.67	28.92	84.73	64.81	71.34	71.18	46.13	49.62	44.87	73.32	44.35

Table 3

Percent diet composition at great and mixed great and double-crested cormorant colonies in Atlantic Canada.

Prey	Exploit- ation status ^a	Great cormorant								Mixed great and double- crested
		Islands near	Islands near	Harbour Rock, near	Mean, Nova Scotia	Magdalen Islands, Que.	Magdalen Islands, Que.	Mean, Magdalen Islands	Grand mean	
		Mushaboom, Halifax Co., NS	Mushaboom, Halifax Co., NS	Gabarous, Cape Breton I.						
Sampling dates		30 May-22Jul 1971	12-22 Jul 1971	24 Jul 1980		16 Jun-16 Aug 1977	23 May-26 Jul 1978			Jun-Jul 1979
Sample type^b	Pellet	Chick vomit		Pel./Vom.		Pel./Vom.	Pel./Vom.			Pel./Vom.
Diet analysis type^c	% numb.	% numb.	% numb.		% numb.	% mass				% number
N	N/A	N/A	42	>42	N/A	N/A				61
Source	Ross 1974- 1976	Ross 1974- 1976	Milton and Austin- Smith 1983		Pilon et al. 1983	Pilon et al. 1983				Milton and Austin- Smith 1983
Freshwater fish										
Brown bullhead	CR				0.00			0.00	0.00	0.40
Estuarine/diadromous fish										
Alewife/blueback herring	C				0.00			0.00	0.00	1.50
Rainbow smelt	CR	0.20			0.07	0.80		0.40	0.23	
American eel	CR			4.90	1.63			0.00	0.82	3.15
White perch	R			2.10	0.70			0.00	0.35	
Banded killifish				0.70	0.23			0.00	0.12	
Mummichog				18.90	6.30			0.00	3.15	
Pelagic fish and squid										
Atlantic herring	C		5.70		1.90		0.30	0.15	1.03	9.55
Capelin	C				0.00	0.40		0.20	0.10	
Sand lance					0.00	25.50	30.60	28.05	14.03	5.80
Marine bottom fish										
Atlantic cod	C	5.50			1.83	0.10		0.05	0.94	0.30
Pollock	C	23.80	1.90		8.57			0.00	4.28	1.10
Unidentified gadids	C	0.80			0.27			0.00	0.13	
Winter flounder	C	11.10	7.50	4.20	7.60			0.00	3.80	
American plaice	C	0.90			0.30			0.00	0.15	
Unidentified flatfish	C				0.00	42.30	34.10	38.20	19.10	
Cunner		41.40	71.70	35.70	49.60	25.40	25.50	25.45	37.53	1.65
Scorpions										
Grubby					0.00	0.10		0.05	0.03	
Longhorn sculpin		6.00			2.00	5.10	3.60	4.35	3.18	
Shorthorn sculpin		10.10			3.37			0.00	1.68	
Unidentified sculpins			13.20	3.50	5.57	0.30	0.50	0.40	2.98	15.90
Blenny-like fishes										
Ocean pout		0.20			0.07		5.50	2.75	1.41	
Rock gunnel				24.50	8.17		0.04	0.02	4.09	51.15
Crustaceans				5.50	1.83			0.00	0.92	9.55
Total commercial and recreational		42.30	15.10	11.20	22.87	43.60	34.40	39.00	30.93	16.00

^aC, commercially fished; R, recreationally fished^bSamples were regurgitated pellets or vomit^cFor a given taxon, diet composition was calculated as percent of total sample mass or percent of total number of prey items

Table 4
Percent diet composition of adult and large young (>250 g) common mergansers in Atlantic Canada.

*C, commercially fished; R, recreationally fished

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When competition is per cent it occurs in all other sites (percent of total number of prey items).

Energy density 0.75 kJ/g wet mass (Cummins and Wuycheck 1971)

^aAdjusted mean calculated from percent of Maritimes Provinces drained by Atlantic salmon rivers and non salmon areas.

Table 4. Common merganser diet (continued)

Prey	St. Mary's River										Miramichi										
	West		East		Main		Long &		North		Chet-		Southwest		Northwest		Middle		River,		
	St.	St.	St.	St.	St.	Eden	Cape	River	Phillip	NS	South-	Ranous	Cains	Dun-	North-	North-	Little	Sev-	Upper	Bath-	
N	Marys	Marys	Marys	Marys	Lakes	Bretton	Island	River	River	NS	South-	west	River	River	west	west	South	South	ogie	urst	NB
Source	White	White	White	White	White	White	White	White	White	NS	South-	west	River	River	west	west	west	west	ogie	urst	NB
Salmonids																					
Atlantic salmon, 0+	66	17	13	1	5	73	6	19	35	4	2	17	38	30	11	8	6	11	2		
Atlantic salmon, 1+	White	1957	1957	1957	1957	1957	1957	1957	1957	1957	1957	1957	1957	1957	1957	1957	1957	1957	1957	1957	1957
Atlantic salmon, 2+	22.5	10.2	4.0	60.0	100.0	90.3	14.9	62.7	37.4	41.2	57.7	17.6	63.4	33.3	69.1	34.3	71.7	51.8	53.7	60.0	21
Atlantic salmon, age unspecified	0.4	0.6																			
Brook trout																					
Brook or rainbow trout																					
Freshwater fish																					
Yellow perch	0.4	2.8	1.0	8.5																	
Brown bullhead																					
Smallmouth bass																					
Pumpkinseed																					
Chain pickerel																					
Golden shiner																					
Common shiner																					
Blacknose shiner, <i>Notropis heterolepis</i>	29.5	10.8	5.1	2.8	12.8	15.4	26.8	28.2	41.2	3.0	10.9	5.8	28.6	3.8	8.9						
Unspecified shiners																					
White sucker	20.1	17.0	18.2	17.5	1.3	17.0	14.8	1.3	1.0	0.7	10.1	3.1	17.1	1.9							
Blacknose dace, <i>Rhinichthys atratulus</i>																					
Redbelly dace, <i>Chrosomus eos</i>	0.1																				
Slimy sculpin, <i>Cottus cognatus</i>																					
Chubs																					
Fallfish, <i>Sennitellus corporalis</i>																					
Creek chub, <i>Semotilus atromaculatus</i>	10.2	3.4	1.0	2.3	6.4	1.4	2.6	5.9	3.7	2.7	5.7	3.8	1.8								
Lake chub, <i>Culaeius plumbeus</i>	6.4																				
Estuarine/diadromous fish																					
Gaspereau	10.8																				
American shad																					
Rainbow smelt																					
American eel	3.6	1.7	1.0	0.6	40.0	0.6	2.1	0.2													
Atlantic tomcod																					
White perch	0.6	4.0	1.0	0.6																	
Three-spine stickleback																					
Four-spine stickleback																					
Nine-spine stickleback																					
Unidentified sticklebacks	0.4																				
Banded killifish	5.5	13.1	3.0	34.5	1.9	34.0	12.0	0.6													
Sea lamprey, <i>Petromyzon marinus</i>																					
Marine bottom fish																					
Cod																					
Amphibians ^c		0.1																			
Unidentified																					
Total commercial and recreational	27.0	27.8	49.5	9.6	100.0	96.2	17.0	84.1	37.7	41.2	57.7	17.6	64.2	39.6	78.5	34.3	75.5	51.8	100.0	60.0	

Table 4. Common munganser diet (continued)

Prey	Restigouche			Port Daniel	Means						Coastal diet*
	Main Branch	Upsal-quitch ^a	Upsal-quitch*		Saint John	St. Marys	Miracle	Restigouche	Other	All sites	
N	271	2	14	66	113	73	174	273	329	946	
Source	Anderson et al. 1985	White 1957	White 1957								
Salmonids											
Atlantic salmon, 0+	25.0										
Atlantic salmon, 1+	20.6										
Atlantic salmon, 2+	27.9	86.1	87.8	25.81	9.20	90.28	48.30	43.06	32.60	34.52	0.62
Atlantic salmon, age unspecified											
Brook trout	0.4		12.2	0.00	0.25	5.33	5.29	0.21	0.80	1.93	2.22
Brook or rainbow trout											
Freshwater fish											
Yellow perch	0.00			3.08	0.00	0.00	0.00	0.00	0.00	0.32	0.37
Brown bullhead	0.00			0.79	0.00	0.00	0.00	0.00	0.61	0.36	0.41
Smallmouth bass	1.87			0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.23
Pumpkinseed	0.37			0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.05
Chain pickerel	0.00			0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.02
Golden shiner	0.00			7.93	0.00	0.00	0.00	0.00	0.63	1.12	1.28
Common shiner	25.41			19.85	0.00	15.69	0.00	0.00	2.41	10.39	11.95
Blacknose shiner, <i>Notropis heterodon</i>	0.00			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Unspecified shiners	3.15			0.14	0.00	0.45	0.00	0.29	0.61	0.70	
White sucker	0.6	2.8	0.0	11.20	18.22	1.25	7.35	1.74	14.85	11.96	13.77
Blacknose dace, <i>Rhinichthys atratulus</i>	0.4	8.3	0.0	10.14	0.42	0.00	8.30	4.38	4.77	5.88	6.77
Redbelly dace, <i>Cinclusomus eos</i>											
Slimy sculpin, <i>Cottus cognatus</i>	0.9	2.8	0.00	0.00	0.00	0.12	1.88	0.04	0.15	0.17	
Chubs											
Fallfish, <i>Semotilus corporalis</i>	9.41	0.00		0.00	2.15	0.00	0.00	0.02	1.62	1.86	
Creek chub, <i>Semotilus atromaculatus</i>	0.19	4.23	0.00	1.70	0.00	0.00	1.97	1.84	2.12		
Lake chub, <i>Cottus plumbeus</i>	0.78	2.72	0.00	4.06	0.00	0.00	4.84	3.71	4.27		
Estuarine/diadromous fish											
Gaspereau	12.3			0.00	13.05	0.00	0.07	7.00	5.20	4.09	4.70
American shad				0.19	0.00	0.00	0.00	0.00	0.02	0.02	0.09
Rainbow smelt				0.00	0.00	0.43	0.00	1.71	0.89	1.02	0.48
American eel	4.23	1.71	0.63	0.28	0.00	0.00	7.15	3.91	4.50	17.89	
Atlantic tomcod	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.01
White perch	0.00	0.39	0.00	0.00	0.00	0.00	0.00	0.66	0.34	0.39	1.54
Threespine stickleback	1.28	3.67	0.00	5.62	0.00	0.00	1.19	2.68	3.08	12.27	
Fourspine stickleback	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.01	0.01	0.05
Ninespine stickleback	0.00	0.25	0.00	0.16	0.00	0.00	3.86	1.80	2.07	8.24	
Unidentified sticklebacks	0.00	0.00	1.88	0.00	0.00	0.00	6.92	3.10	3.56	14.18	
Banded killifish	5.33	14.01	0.63	0.02	0.00	5.90	4.68	5.39	21.44		
Sea lamprey, <i>Petromyzon marinus</i>	0.0	0.64	0.00	0.00	0.00	0.00	0.32	0.21	0.24	0.97	
Marine bottom fish											
Cod	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.02	0.02	0.09
Amphibians*	0.0		0.00	0.04	0.00	0.00	0.00	0.20	0.09	0.11	0.43
Unidentified	12.1										
Total commercial and recreational	86.1	86.1	100.0	32.5	28.5	96.2	54.4	92.0	51.8	50.2	42.6
											42.4

Table 5
Diet of red-breasted and hooded mergansers in the Maritime Provinces.

Prey	Exploit- ation status ^a	Red-breasted merganser								Hooded merganser
		Crecy Lake, Charlotte Co., NB	Belle Isle Bay, Saint John River	Petit- codiac River	Margaree River	North- west Miramichi River	Bartibo River	Pond, location not given	Means ^b	
N		14	1	5	11	1	2	3	37	17
Diet analysis type ^c		% occur.	% numb.	% numb.	% numb.	% numb.	% numb.	% numb.		% occur.
Source		Smith 1967	White 1957	White 1957	White 1957	White 1957	White 1957	White 1957		Smith 1967
Salmonids										
Atlantic salmon	R			7.1	63.4	11.1			11.7	0.49
Brook or rainbow trout	R	35.7							4.5	0.19
										5.9
Freshwater fish										
Golden shiner				10.7		5.6	33.7	7.1		0.30
Unspecified minnows			60.0	32.1		61.1		21.9		0.91
White sucker			20.0	32.1		16.7	3.0	10.3		0.43
Blacknose and redbelly dace		7.1						0.9		0.04
Estuarine/diadromous fish										
Rainbow smelt	CR				5.9		0.8	2.1	2.01	
American eel	CR					1.0	0.1	0.3	0.34	
Twospined stickleback					11.8		1.7	4.1	4.01	
Threespine stickleback					70.6	33.7	14.9	36.5	35.56	
Fourspine stickleback						28.7	4.1	10.0	9.80	
Unidentified sticklebacks		17.9	23.9	5.6			6.8	16.6	16.16	
Banded killifish		71.4		5.6		11.8	11.4	27.9	27.26	23.5
Marine bottom fish										
Cunners				4.2			0.6	1.5	1.44	
Sculpins				2.8			0.4	1.0	0.96	
Insects^d		20.0					2.9		0.12	
Total commercial and recreational		35.7	0.0	7.1	63.4	11.1	5.9	1.0	17.1	2.4
										3.0
										5.9

^aC, commercially fished; R, recreationally fished

^bThe raw mean is the mean of measured diets. The coastal mean is calculated from estuarine and marine prey in the raw mean, scaled up to 100%. The nesting season mean is the mean of the raw and coastal diets, weighted by the proportion of birds occupying fresh water during this period (see text).

^cFor a given taxon, diet composition was calculated as percent of total number of prey items (% numb.) or percent of stomachs in which the taxon occurred (% occur.)

^dEnergy density 3.18 kJ/g wet mass (Cummins and Wuycheck 1971)

Table 6
Diet of belted kingfishers in the Maritime Provinces

Prey	Exploit- ation status ^a	Crecy Lake, Charlotte Co., NB		Saint John system						Petitcodiac system		
		Salmon River	Tobique River	Nash- waak River	Washa- demoak Lakes	Grand & Canaan River	Upper Kenne- becasis Creek	Cascabac	Cover- dale River	Polet River	North River	
Sampling dates		1952- 1963	1940s	10 Sep 1948	1948	1940s	1940s	1948	1948	1948	1946- 1949	1944- 1945
Sample type ^b		Stom.	Pel.	Pel.	Pel.	Pel.	Pel.	Pel.	Pel.	Pel.	Pel./Stom	Pel.
Diet analysis type ^c		% occur.	% numb.	% numb.	% numb.	% numb.	% numb.	% numb.	% numb.	% numb.	% numb.	% numb.
N		59	8	33	27	7	9	61	8	34	97	41
Source		Smith 1967	White 1953	White 1953	White 1953	White 1953	White 1953	White 1953	White 1953	White 1953	White 1953	White 1953
Salmonids												
Atlantic salmon, 0+	R											
Atlantic salmon, 1+	R											
Atlantic salmon, 2+	R											
Atlantic salmon, age unspecified	R		53.8	16.0	39.1		6.3	2.8	12.5	27.3	12.2	2.2
Brook trout	R			2.4				18.8		2.0	8.9	1.8
Brook or rainbow trout	R	28.8										
Unidentified salmonids	R											
Freshwater fish												
Yellow perch	CR					20.0						
Brown bullhead	CR					5.0						
Chain pickerel	R					15.0	31.3					
Golden shiner						35.0						
Common shiner			14.4	14.1	5.0	6.3	2.1	6.3				0.9
Blacknose shiner												
Unidentified Cyprinidae												
White sucker			11.2	4.7	5.0	12.5	1.7	3.1	7.1	18.8		24.0
Blacknose dace			16.8	21.9	5.0		4.5	46.9	15.2	11.4		7.1
Redbelly dace									10.1			5.3
Blacknose and redbelly dace	1.7											
Slimy sculpin		19.2	8.8	1.6			35.2		6.1	1.9		
Chubs												
Fallfish				3.2			37.5					
Creek chub					3.1			2.1				
Lake chub		11.5	5.6				1.4	6.3	29.3	40.7		21.8
Estuarine/diadromous fish												
Gaspereau	C		6.4									
Rainbow smelt	CR											
American eel	CR					5.0			21.9	1.0	0.6	3.1
Atlantic tomcod	CR											
Atlantic silverside	C											
White perch	R											
Threespined stickleback					3.1			31.4		2.0	1.9	9.8
Blackspotted stickleback, <i>Gasterosteus wheatlandi</i>												
Fourspined stickleback					1.6						0.6	1.3
Ninespined stickleback												
Unidentified sticklebacks												
Banded killifish	30.5		1.6	5.0	6.3					0.3	18.7	
Mummichog												
Unidentified Cyprinodontidae												
Marine bottom fish												
Winter flounder	C											
Unidentified sculpins												
Crustaceans												
Crayfish		15.4	12.0	9.4								
Amphibians					0.8							0.4
Insects					2.4				3.1	0.3	0.9	
Mammals												
Shrew, <i>Sorex palustris</i>												
Total commercial and recreational		28.8	53.8	24.8	39.1	45.0	37.5	21.6	34.4	30.3	21.6	7.1

^aC, commercially fished; R, recreationally fished.

^bSample types were regurgitated pellets (Pellet) and stomach contents of birds which were shot (Stomach).

^cFor a given taxon, diet composition was calculated as percent of total number of prey items (% number) or percent of stomachs containing the prey type (% occur.).

^dWeighted mean calculated from percent of Maritimes Provinces drained by Atlantic salmon rivers (74%, ASA 1980), and by assuming that composition of non-salmon prey is the same in salmon areas and non salmon areas.

Table 6. Kingfisher diet (continued)

Prey	Apple River & vicinity, Cumber-land Co., NS	Bass River, NS	Debert River, NS	Herbert River, NS	Gas-pereau River, NS	Gas-pereau Lake, NS	Small ponds & lakes, central NS	Moser River, NS	Mar-garee River	Mar-garee River	Mar-garee River and estuary	Margaree system	Upper North-east Mar-garee	Forest Glen Brook	Forest Glen Brook
Sampling dates	1936	1948	1948	1948	1948	1940s	1940s	1940-42	30 Jul-17 Aug 1935	1935	1936	1937	1937	1937	1937
Sample type ^b	Pel.	Pel.	Pel.	Pel.	Pel.	Pel.	Pel.	Pel.	Stom.	Pel.	Pel.	Ch. stom.	Stom.	Pel.	
Diet analysis type ^c	% numb. N	% numb. White	% numb. White	% numb. White	% numb. White	% numb. White	% numb. White	% numb. White	% numb. White	% numb. White	% numb. White	% numb. White	% numb. White	% numb. White	% numb. White
Source	1937	1953	1953	1953	1953	1953	1953	1953	1936	1936	1937	1938	1939	1939	1939
Salmonids															
Atlantic salmon, 0+														7.5	57.8
Atlantic salmon, 1+														43.9	8.3
Atlantic salmon, 2+														0.6	15.1
Atlantic salmon, age unspecified	15.2	26.5								5.2	63.2			10.7	12.4
Brook trout	34.2	2.9	25.0	6.3	50.0					2.1	3.5	15.5	3.4	15.4	29.9
Brook or rainbow trout															37.8
Unidentified salmonids														3.5	
Freshwater fish															
Yellow perch									16.0	5.0					
Brown bullhead									1.8						
Chain pickerel															
Golden shiner									2.9	2.5	6.8				
Common shiner											4.7				
Blacknose shiner															
Unidentified Cyprinidae															
White sucker						31.3			2.9	4.2	4.2	3.5	0.4	0.5	
Blacknose dace															
Redbelly dace															
Blacknose and redbelly dace															
Slimy sculpin			14.7												
Chubs															
Fallfish															
Creek chub						25.0				2.5					
Lake chub		2.9			37.5		7.1			0.8	0.5				
Estuarine/diadromous fish															
Gaspereau									15.0					2.4	
Rainbow smelt															
American eel								7.1			3.1				
Atlantic tomcod		3.8													
Atlantic silverside															
White perch									6.1	1.7				8.3	
Threespined stickleback	5.1	47.1	75.0											33.0	1.8
Blackspotted stickleback, <i>Gasterosteus</i>														4.4	2.4
Fourspined stickleback															
Ninespined stickleback	5.1								44.4	78.3				0.5	
Unidentified sticklebacks											5.2	26.3	31.8		
Banded killifish									35.7	10.5	3.3	12.6	0.4	10.2	
Mummichog	36.7	5.9												26.2	
Unidentified Cyprinodontidae															
Marine bottom fish															
Winter flounder														0.5	
Unidentified sculpins															
Crustaceans															
Crayfish															
Amphibians									0.3						
Insects									0.3	1.7	1.0				
Mammals															
Shrew, <i>Sorex palustris</i>														0.2	
Total commercial and recreational	53.2	29.4	25.0	6.3	57.1	38.7	6.7	64.9	70.2	67.5	25.2	100.0	98.0	97.6	

Table 6. Kingfisher diet (continued)

Prey	West River, NS	Wallace River, NS	Morell River, PEI	Clarkes and Forbes Brooks, PEI	Upper Richibuctou River, NB	Upper Kouchibouguac River, NB	Barnaby River	Bartholomew River	Miramichi system west Miramichi	Southwest Miramichi	Northwest Miramichi	Indiantown Brook	Bartibog River	Restigouche River
Sampling dates	1948	1948	Summer 1948	17 Jun 1948	1948	1948	1940s	1948	28 Aug 1948	Jun 19 Aug 19	15 Jun, 27 Aug 1948	1948	11-12 Sep 1948	
Sample type^b	Pel.	Pel.	Pel	Pel.	Pel.	Pel.	Pel.	Pel.	Pel.	Pel.	Pel.	Pel.	Pel.	Pel.
Diet analysis type^c	% numb. N	% numb. 5	% numb. 9	% numb. 15	% numb. 2	% numb. 1	% numb. 30	% numb. 11	% numb. 14	% numb. 29	% numb. 5	% occur. 6	% numb. 188	
Source	White 1953	White 1953	White 1953	White 1953	White 1953	White 1953	White 1953	White 1953	White 1953	White 1953	White 1953	White 1953	White 1953	
Salmonids														
Atlantic salmon, 0+														
Atlantic salmon, 1+														
Atlantic salmon, 2+														
Atlantic salmon, age unspecified	80.0	18.8	30.1		100.0	33.3	2.8	2.3	6.5	24.1		13.0	5.2	
Brook trout		31.3	6.7	2.9						6.9		4.3	1.6	
Brook or rainbow trout														
Unidentified salmonids														
Freshwater fish														
Yellow perch														
Brown bullhead														
Chain pickerel														
Golden shiner														
Common shiner		18.8												
Blacknose shiner														
Unidentified Cyprinidae														
White sucker														
Blacknose dace		6.3												
Redbelly dace														
Blacknose and redbelly dace														
Slimy sculpin														
Chubs														
Fallfish														
Creek chub														
Lake chub	20.0													
Estuarine/diadromous fish														
Gaspereau													3.6	
Rainbow smelt		13.3	38.3									60.0		
American eel														
Atlantic tomcod														
Atlantic silverside														
White perch														
Threespined stickleback	25.0	33.4	47.1											
Blackspotted stickleback, <i>Gasterosteus</i>														
Fourspined stickleback		3.3	2.9											
Ninespined stickleback														
Unidentified sticklebacks		3.3	2.9											
Banded killifish		3.3	2.9											
Mummichog		3.3	2.9											
Unidentified Cyprinodontidae														
Marine bottom fish														
Winter flounder														
Unidentified sculpins														
Crustaceans														
Crayfish														
Amphibians														
Insects			3.3											
Mammals														
Shrew, <i>Sorex palustris</i>														
Total commercial and recreational	80.0	50.0	50.1	41.2	100.0	33.3	2.8	2.3	6.5	31.0	60.0	17.4	10.3	

Table 6. Kingfisher diet (continued)

Prey	Jardin Brook (Restigouche system), upper Caraquet and Pokemouche Rivers, NB	Cocagne & Bass Rivers, NB, Nine-mile River, NS	North- umber- land Strait, NS & PEI	North- umber- land Strait, NB	Tabus- Intac estuary, NB	Saint John	Mar- garee	Mira- michi	Resti- gouche	Means			
										All sites, Atlantic salmon removed	All sites, Atlantic salmon removed	Weight- ed mean, Mari- times ^d	
Sampling dates	1948	1940s	1940s	1940s	1940s								
Sample type ^b	Pel.	Pel.	Pel.	Pel.	Pel.								
Diet analysis type ^c	% numb.	% numb.	% numb.	% numb.	% numb.								
N	13	27	46	27	33	153	395	89	188	564	1389		
Source	White 1953	White 1953	White 1953	White 1953	White 1953								
Salmonids													
Atlantic salmon, 0+						0.00	16.25	0.00	0.00	0.00	2.27		1.68
Atlantic salmon, 1+						0.00	22.34	0.00	0.00	0.00	3.12		2.31
Atlantic salmon, 2+						0.00	5.49	0.00	0.00	0.00	0.77		0.57
Atlantic salmon, age unspecified		3.7		0.7	18.64	12.31	7.14	5.16	15.34	14.26		10.55	
Brook trout	47.1		1.7		3.03	17.59	1.38	1.59	9.47	8.43	10.59	8.99	
Brook or rainbow trout									1.97	1.10	1.38	1.17	
Unidentified salmonids						0.00	0.58	0.00	0.00	0.00	0.08	0.10	0.09
Freshwater fish													
Yellow perch						2.86	0.00	0.00	0.00	0.87	0.95	1.20	1.02
Brown bullhead						0.71	0.00	0.00	0.00	0.07	0.15	0.19	0.16
Chain pickerel						6.61	0.00	0.00	0.00	0.00	1.08	1.35	1.15
Golden shiner						5.00	0.00	0.11	0.00	0.51	1.11	1.40	1.18
Common shiner		5.6				6.87	0.00	12.12	0.40	1.21	3.21	4.03	3.43
Blacknose shiner						0.00	0.00	0.00	0.00	0.04	0.02	0.03	0.02
Unidentified Cyprinidae	1.5					0.00	0.00	0.11	0.00	0.24	0.15	0.19	0.16
White sucker		22.2				5.46	0.73	14.58	2.38	6.35	8.28	7.89	6.70
Blacknose dace		9.3				13.58	0.00	7.44	0.00	3.62	5.09	6.40	5.43
Redbelly dace		0.9				0.00	0.00	0.00	0.00	0.68	0.38	0.48	0.41
Blacknose and redbelly dace						0.00	0.00	0.00	0.00	0.12	0.06	0.08	0.07
Slimy sculpin	44.1					9.26	0.00	0.91	1.98	2.78	3.21	4.04	3.43
Chubs													
Fallfish						5.81	0.00	2.32	0.00	0.00	1.22	1.53	1.30
Creek chub		3.7				0.75	0.00	2.07	0.00	1.88	1.41	1.77	1.50
Lake chub		0.9				3.54	0.00	4.93	0.40	6.74	4.92	6.18	5.25
Estuarine/diadromous fish													
Gaspereau						0.91	0.40	0.00	3.57	2.89	1.90	2.39	2.03
Rainbow smelt		3.7	2.6			0.00	0.00	12.00	0.00	2.41	2.74	3.44	2.92
American eel		0.9				3.84	0.00	0.00	0.00	0.68	0.99	1.25	1.06
Atlantic tomcod						0.00	0.00	0.00	0.00	0.16	0.09	0.11	0.09
Atlantic silverside		0.9	14.5			0.00	1.38	0.00	0.00	0.64	0.55	0.69	0.59
White perch						0.00	0.00	0.00	0.00	0.32	0.18	0.23	0.19
Threespined stickleback	7.4		13.7	34.4	49.7	4.93	6.20	2.91	0.40	15.37	10.59	13.31	11.30
Blackspotted stickleback, <i>Gasterosteus</i>						0.00	0.73	0.00	0.00	0.00	0.10	0.13	0.11
Fourspined stickleback		36.1		0.8	0.7	0.00	0.00	0.00	0.00	1.90	1.06	1.33	1.13
Ninespined stickleback		4.6	4.3	9.9	6.1	0.22	0.08	1.49	0.00	7.81	4.58	5.78	4.89
Unidentified sticklebacks		9.4	17.6	10.2	0.00	9.68	0.00	0.00	0.00	2.03	2.48	3.12	2.65
Banded killifish		5.6		0.8		1.83	1.76	0.00	0.00	5.99	3.88	4.88	4.14
Mummichog			63.2	19.8	32.7	0.00	4.37	0.00	0.00	6.86	4.44	5.57	4.73
Unidentified Cyprinodontidae						0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Marine bottom fish													
Winter flounder		0.9	1.5			0.00	0.08	0.00	0.00	0.10	0.07	0.08	0.07
Unidentified sculpins		3.4	0.8			0.00	0.00	0.00	0.00	0.17	0.10	0.12	0.10
Crustaceans													
Crayfish						5.25	0.00	28.71	84.13	0.00	6.15	7.73	6.56
Amphibians		0.9				0.11	0.00	0.26	0.00	0.07	0.09	0.11	0.09
Insects			1.9			0.79	0.00	1.52	0.00	0.75	0.72	0.91	0.77
Mammals													
Shrew, <i>Sorex palustris</i>						0.00	0.04	0.00	0.00	0.00	0.01	0.01	0.01
Total commercial and recreational	47.1	8.3	6.0	16.0	0.7	36.60	76.41	20.52	10.32	34.9	38.72	23.01	34.64

Table 7
Summary of cormorant, merganser, and kingfisher diets in northeastern North America.

Prey	Double-crested cormorant												Great cormorant			
	Gulf of Maine		Atlantic NS		PEI		Maritime			Que.		All regions		Nova Scotia	Magdalens	All sites
	Smolt run	Non smolt run	Smolt run	Non smolt run	Smolt run	Non smolt run	Smolt run	Non smolt run, adjusted	Overall adjusted mean	Non smolt run	Smolt run	Non smolt run	Non smolt run	Smolt run	Non smolt run	
N	495	>1433	148	>268	230	211	495		>479	>974	2080	873	>4352	>42	N/A	N/A
Salmonids																
Atlantic salmon	39.3	0.4	9.5	0.0	3.1	0.0	4.8	3.3	0.0	0.5	0.0	17.3	0.1	0.0	0.0	0.0
Brook trout	0.0	0.0	0.2	0.0	0.8	7.4	0.5	0.5	5.4	4.7	0.1	0.3	1.9	0.0	0.0	0.0
Other and unidentified salmonids	0.0	0.0	13.6	0.0	0.0	0.0	4.5	4.6	0.0	0.6	0.0	4.5	0.0	0.0	0.0	0.0
Total salmonids	39.3	0.4	23.2	0.0	4.0	7.4	9.7	8.4	5.4	5.8	0.1	22.2	2.0	0.0	0.0	0.0
Freshwater fish																
Commercial/recreational																
Yellow perch	2.9	0.6	6.3	0.3	0.0	0.0	2.1	2.1	0.1	0.4	0.0	3.1	0.2	0.0	0.0	0.0
Centrarchids	3.7	6.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.2	1.7	0.0	0.0	0.0
Other	1.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0
Total	7.6	7.5	6.3	0.3	0.0	0.0	2.1	2.1	0.1	0.4	0.0	4.6	1.9	0.0	0.0	0.0
Non-commercial/recreational																
Sucker (mostly white sucker)	3.2	3.0	7.6	0.1	0.0	0.0	2.5	2.6	0.0	0.4	0.0	3.6	0.8	0.0	0.0	0.0
Other	7.9	0.7	1.7	0.0	0.0	0.0	0.6	0.6	0.0	0.1	0.0	3.2	0.2	0.0	0.0	0.0
Total	11.1	3.7	9.4	0.1	0.0	0.0	3.1	3.1	0.0	0.5	0.0	6.8	1.0	0.0	0.0	0.0
Total	18.7	11.2	15.7	0.4	0.0	0.0	5.2	5.3	0.2	0.9	0.0	11.5	2.9	0.0	0.0	0.0
Estuarine/diadromous fish																
Commercial/recreational																
Gaspereau	4.8	8.6	16.3	0.9	0.0	11.9	7.6	7.7	9.6	9.4	0.0	7.0	5.3	0.0	0.0	0.0
Rainbow smelt	2.6	2.2	1.5	0.1	80.8	22.7	41.5	41.7	0.9	6.6	0.5	28.3	6.4	0.1	0.4	0.2
American eel	3.1	4.2	8.5	1.3	0.0	3.7	2.8	3.5	3.5	3.5	1.0	3.8	2.6	1.6	0.0	0.8
Other	1.2	3.1	5.0	0.4	0.0	6.8	1.7	2.0	5.5	5.0	2.0	2.0	3.1	0.7	0.0	0.4
Total	11.7	18.1	31.2	2.6	80.8	45.1	53.7	54.9	19.4	24.4	3.5	41.2	17.3	2.4	0.4	1.4
Non-commercial/recreational																
Sticklebacks	2.7	0.9	7.1	0.1	15.3	12.0	10.5	10.5	4.3	5.1	0.8	8.4	3.4	0.0	0.0	0.0
Cyprinodontidae	0.6	2.4	2.0	0.0	0.0	8.1	0.8	0.8	4.8	4.2	0.1	0.9	2.1	6.5	0.0	3.3
Other	0.2	0.7	0.5	0.0	0.0	0.0	0.2	0.2	0.0	0.0	0.0	0.2	0.2	0.0	0.0	0.0
Total	3.6	3.9	9.6	0.1	15.3	18.1	11.4	11.4	9.0	9.4	0.9	9.5	5.7	6.5	0.0	3.3
Total	15.2	22.0	40.8	2.7	96.0	63.2	65.0	66.3	28.5	33.7	4.4	50.7	23.1	8.9	0.4	4.7
Pelagic fish and squid																
Commercial																
Atlantic herring	0.6	1.7	0.0	3.1	0.0	0.0	0.2	0.2	1.4	1.2	12.0	0.2	4.2	1.9	0.2	1.0
Capelin	0.0	0.0	0.5	0.0	0.0	0.0	0.2	0.2	0.0	0.0	14.9	0.2	3.7	0.0	0.2	0.1
Other	2.5	2.6	2.1	0.2	0.0	0.0	1.7	1.7	0.1	0.3	0.2	1.5	0.7	0.0	0.0	0.0
Total	3.1	4.3	2.6	3.3	0.0	0.0	2.1	2.1	1.5	1.6	27.0	1.9	8.7	1.9	0.4	1.1
Non-commercial																
Sand lance	0.0	0.0	6.7	2.4	0.0	0.0	2.2	2.2	1.0	1.2	17.9	2.2	5.1	0.0	28.1	14.0
Other	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	0.0	0.0	6.7	2.4	0.0	0.0	2.2	2.2	1.0	1.2	17.9	2.2	5.1	0.0	28.1	14.0
Total	3.1	4.3	9.3	5.7	0.0	0.0	4.3	4.4	2.5	2.8	44.9	4.1	13.7	1.9	28.4	15.2
Marine bottom fish																
Commercial																
Atlantic cod	0.0	0.0	1.4	10.9	0.0	0.0	0.5	0.5	4.8	4.2	0.6	0.5	2.9	1.8	0.1	0.9
Pollock	0.0	1.1	0.2	7.8	0.0	0.0	0.1	0.1	3.5	3.0	0.0	0.1	2.2	8.6	0.0	4.3
Hake, mostly white hake	0.0	0.0	0.2	0.3	0.0	5.3	0.1	0.1	4.3	3.7	0.0	0.1	1.4	0.0	0.0	0.0
Flatfish																
Winter flounder	0.6	4.8	0.3	3.4	0.0	0.0	0.7	0.7	1.5	1.4	0.0	0.3	2.1	7.6	0.0	3.8
Other	0.3	0.8	0.0	0.2	0.0	7.0	0.0	0.0	5.5	4.8	13.6	0.1	5.4	0.3	38.2	19.3
Total	0.9	5.6	0.3	3.6	0.0	7.0	0.7	0.7	7.0	6.2	13.6	0.4	7.5	7.9	38.2	23.1
Other	0.0	1.7	7.3	0.1	0.0	0.0	2.4	2.4	0.0	0.4	0.0	2.4	0.5	0.3	0.0	0.1
Total	0.9	8.5	9.3	22.7	0.0	12.3	3.7	3.7	19.7	17.4	14.3	3.4	14.4	18.6	38.3	28.4
Non-commercial																
Cunner	0.3	17.8	0.0	27.4	0.0	12.0	0.0	0.0	21.5	18.5	5.0	0.1	15.6	49.6	25.5	37.5
Sculpins	9.3	18.2	0.8	16.5	0.0	4.3	9.5	9.6	10.7	10.5	24.1	3.4	15.8	10.9	4.8	7.9
Blenny-like fishes	1.2	5.8	0.8	23.7	0.0	0.4	1.4	1.4	10.9	9.5	7.0	0.7	9.2	8.2	2.8	5.5
Other	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	10.8	41.8	1.6	67.6	0.0	16.8	10.9	10.9	43.1	38.6	36.0	4.1	40.6	68.8	33.0	50.9
Total	11.7	50.3	11.0	90.3	0.0	29.1	14.5	14.6	62.8	56.0	50.3	7.6	55.0	87.3	71.3	79.3
Crustaceans	11.0	10.8	0.0	1.0	0.0	0.3	1.1	1.1	0.6	0.7	0.3	3.7	3.1	1.8	0.0	0.9
Molluscs	1.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.3	0.0	0.0	0.0
Insects	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Amphibians	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total commercial and recreational	62.5	38.7	72.7	28.9	84.7	64.8	71.3	71.1	46.1	49.6	44.9	73.3	44.3	22.9	39.0	30.9

Table 7. Diet summary (continued).

Prey	Common merganser										Red-breasted merganser		Belted kingfisher									
	Major salmon rivers					Other sites	All sites	Adjusted mean, Mari-times	Coastal adjusted	Needing sites		Coastal adjusted	Major salmon rivers					Other sites	All sites	Adjusted mean, Mari-times		
	Saint John	St. Mary	Marie	Mira-	Restigouche					Needing season, adjusted	Coastal adjusted		Saint John	Marie	Mira-	Restigouche	Other sites					
N	66	113	73	174	273	329	946					37	153	395	89	188	564	1389				
Salmonids																						
Atlantic salmon	25.8	9.2	90.3	48.3	84.8	32.6	36.7	27.2	0.5	18.6	56.4	7.1	5.2	15.3	20.4	14.9						
Brook trout	0.0	0.3	5.3	5.3	0.2	0.8	1.9	2.2	0.2	3.0	17.6	1.4	1.6	9.5	8.4	8.9						
Other and unidentified salmonids	0.0	0.0	0.0	0.0	0.0	2.9	1.3	1.5	0.0	0.0	0.6	0.0	0.0	2.0	1.2	1.3						
Total salmonids	25.8	9.4	95.6	53.6	85.0	36.3	40.0	30.9	0.7	21.7	74.5	8.5	6.7	26.8	30.0	25.0						
Freshwater fish																						
Commercial/recreational																						
Yellow perch	0.0	3.1	0.0	0.0	0.0	0.0	0.3	0.4	0.0	2.9	0.0	0.0	0.0	0.9	1.0	1.0						
Centrarchids	2.2	0.0	0.0	0.0	0.0	0.0	0.2	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0						
Other	0.0	0.8	0.0	0.0	0.0	0.7	0.4	0.4	0.0	7.3	0.0	0.0	0.0	0.1	1.2	1.3						
Total	2.2	3.9	0.0	0.0	0.0	0.7	0.9	1.1	0.0	10.2	0.0	0.0	0.0	0.9	2.2	2.3						
Non-commercial/recreational																						
Sucker (mostly white sucker)	11.2	18.2	1.3	7.4	1.7	14.9	12.0	13.8	0.4	5.5	0.7	14.6	2.4	6.3	6.3	6.6						
Other	49.1	35.3	0.0	32.5	6.3	15.0	25.3	29.1	1.2	44.8	0.0	30.0	2.8	17.8	20.8	21.9						
Total	60.3	53.6	1.3	39.8	8.0	29.8	37.3	42.9	1.7	50.3	0.7	44.6	5.2	24.2	27.1	28.5						
Total	62.5	57.4	1.3	39.8	8.0	30.5	38.2	44.0	1.7	60.4	0.7	44.6	5.2	25.1	29.3	30.8						
Estuarine/diadromous fish																						
Commercial/recreational																						
Gaspereau	0.0	13.1	0.0	0.1	7.0	5.2	4.1	4.7	18.7	0.0	0.0	0.9	0.4	0.0	3.6	2.9	1.9	2.0				
Rainbow smelt	0.0	0.0	0.0	0.4	0.0	1.7	0.9	1.0	4.1	2.0	2.1	0.0	0.0	12.0	0.0	2.4	2.7	2.9				
American eel	4.2	1.7	0.6	0.3	0.0	7.2	3.9	4.5	17.9	0.3	0.3	3.8	0.0	0.0	0.0	0.7	1.0	1.0				
Other	0.2	0.4	0.0	0.0	0.0	0.7	0.4	0.4	1.6	0.0	0.0	0.0	1.4	0.0	0.0	1.1	0.8	0.9				
Total	4.4	15.2	0.6	0.8	7.0	14.7	9.2	10.6	42.3	2.3	2.4	4.8	1.8	12.0	3.6	7.1	6.5	6.8				
Non-commercial/recreational																						
Sticklebacks	1.3	3.9	1.9	5.8	0.0	12.0	7.6	8.7	34.7	65.5	67.2	5.2	16.7	4.4	0.4	27.1	18.8	19.8				
Cyprinodontidae	5.3	14.0	0.6	0.0	0.0	5.9	4.7	5.4	21.4	27.3	27.9	1.8	6.1	0.0	0.0	12.8	8.3	8.8				
Other	0.6	0.0	0.0	0.0	0.0	0.3	0.2	0.2	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
Total	7.3	17.9	2.5	5.8	0.0	18.2	12.5	14.4	57.1	92.8	95.1	7.0	22.8	4.4	0.4	40.0	27.1	28.6				
Total	11.7	33.1	3.1	6.6	7.0	32.9	21.7	25.0	99.5	95.1	97.5	11.7	24.6	16.4	4.0	47.0	33.6	35.4				
Pelagic fish and squid																						
Commercial																						
Atlantic herring	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Capelin	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Other	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Non-commercial																						
Sand lance	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Other	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Marine bottom fish																						
Commercial																						
Atlantic cod	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Pollock	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Hake, mostly white hake	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Flatfish																						
Winter flounder	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.1	0.1	0.1	0.1	0.1	
Other	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Other	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Non-commercial																						
Cunner	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.4	1.5	0.0	0.0	0.0	0.0	0.2	0.1	0.1	0.1	0.1	0.1	
Scorpions	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Blenny-like fishes	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Other	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.4	2.5	0.0	0.0	0.0	0.0	0.0	0.2	0.1	0.1	0.1	0.1	
Total	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.4	2.5	0.0	0.0	0.0	0.0	0.0	0.3	0.2	0.2	0.2	0.2	
Crustaceans																						
Molluscs	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.3	0.0	28.7	84.1	0.0	6.1	7.8						
Insects	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Amphibians	0.0	0.0	0.0	0.0	0.0	0.2	0.1	0.1	0.4	0.0	0.0	0.1	0.0	0.3	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Total commercial and recreational	32.5	28.5	96.2	54.4	92.0	51.8	50.2	42.6	42.4	3.0	2.4	36.6	76.4	20.5	10.3	34.9	38.7	34.2				